Clinical Evaluation of Transcutaneous Electrical Nerve Stimulation (TENS) for Various Treatment Procedures in Pediatric dentistry

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Abstract

The most distressing aspect of dentistry for the average dental patient is the fear and anxiety caused by the dental environment, particularly the dental injection referred to as "Needle-phobia" or "Blenophobia". Many children and even adults are afraid of syringes and needle insertions. This procedure is considered unpleasant from physical, chemical and psychological standpoints. Reducing this fear in children may help to provide overall comfort and well being during the entire dental experience. The challenge is to find an effective method that can be utilized in the pediatric population as an alternative to injectable local anesthetics. Transcutaneous Electrical Nerve Stimulation (TENS) also known as Electronic Dental Anesthesia (EDA) is non-invasive, safe and well accepted by the patients. It has been shown that EDA is a viable mode of pain control during some dental procedures in pediatric dentistry. This study was conducted to clinically evaluate the effectiveness of EDA in various dental procedures as an alternative to injectable local anaesthetics, details of the study are discussed in the present paper.

KEYWORDS: **Electronic Dental Anesthesia (EDA), Transcutaneous Electrical Nerve Stimulation (TENS),Local Anesthesia.**

Introduction

The most distressing aspect of dentistry for the average dental patient is the fear and anxiety caused by the dental environment, particularly the dental injection[1,2,3] referred to as "Needle-phobia" or "Blenophobia". Many children and even adults are afraid of syringes and needle insertions. This procedure is considered unpleasant from physical, chemical and psychological standpoints[4].

Reducing this fear in children may help to provide overall comfort and well being during the entire dental experience. Pediatric dentists are constantly searching for tools, which may provide a more comfortable dental procedure.[5] The challenge is to find an effective method that can be utilized in the pediatric population as an alternative to injectable local anesthetics.

An alternative method of pain control, which has received little attention in dentistry is Transcutaneous Electrical Nerve Stimulation (TENS) also known as Electronic Dental Anesthesia (EDA).It is non-invasive, safe and well accepted by the patients. It has been shown that EDA is a viable mode of pain control during some dental procedures in pediatric dentistry[6,7] and it appears to be a substantial alternative to the other conventional local anesthetic techniques.[8]

So to provide feasible alternative in dentist's pain control armamentarium the present study is intended clinically to evaluate the effectiveness of EDA in various pediatric dental procedures as an alternative to injectable local anesthetics.

Materials and Methods :

Children aged between 6-12 years who were attending the pediatric dental clinic at College of Dental Sciences, Davangere were considered for this study. These children seeking dental treatment such as extraction and pulp therapy under local anesthesia were selected for the study upon fulfilling the following criteria:

- Healthy and cooperative
- No medical contraindications for the use of electronic dental anesthesia such as ;
    - Heart disease, cardiac pacemakers
    - Seizure disorders
    - Neurologic diseases
    - Cerebrovascular diseases
    - Cochlear implants.

Before starting the treatment under EDA, the entire procedure, legal formalities and the inherent risks involved were explained to the parents/guardians in local language following which an informed written consent was obtained. The ethical clearance for the study was obtained from the ethical committee before starting the study.

Treatment Categories: 63 children in the age group of 6-12 years were selected for the study and divided into following 3 groups.

a) Extraction group - 22
b) Pulp therapy group - 19
c) Stainless steel crowns - 23

Equipment : The apparatus used was Transcutaneous nerve stimulator T.N.S. model MS 979 marketed by modern co-operative industrial society, Howrah (Photograph 1).

TNS MS 979 has control unit and electrode pads. It consists of two independent, separate galvanic channels. Each channel has individual amplitude control and single frequency control knob.

It generates current through 6V battery capable of producing current at amplitude ranging form 1-20 mA at frequency anywhere between 2-50 Hz and it has a fixed pulse width of 400 μSec.

Fig 1. TENS Machine and Materials used for EDA

Mechanism of action[9] : The use of TENS is based on several interrelated theories on the mechanism of pain transmission and the blocking of these mechanisms.

The first of these theories is the gate control theory proposed by Melzac and Wall. Another explanation for the effectiveness of TENS is the electric stimulation causes a release of endorphins, which attaches to opiate receptors and block transmission of painful stimuli.

Another theory is that serotonin, dopamine, and norepinephrine are produced, which have roles in the effects of stimulation produced analgesia and that an increase in serotonin has a direct relationship with the analgesic effect produced by TENS.

The exact mechanism of pain control with electronic anesthesia remains unknown and may be combination of one or more theories.

Procedure : The actual procedure commenced only after briefing the patient in simple terms about the technique, followed by determination of electrode pad placement, depending on treatment to be performed.

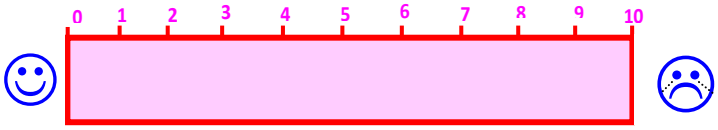
- The site of electrode pad placement was gently swabbed with surgical spirit to remove any skin oils or substance that may interfere with current flow.
- Electrode gel was applied on the electrode pads before placement.
- After predetermining the position of electrode pads, the patient was asked to keep his/her mouth open as done during the treatment, then the electrode pads were secured in place using surgical tape to minimize displacement (Photograph 2).

Fig 2. Electrode placement on the patient.

- The system was switched on and the investigator controlled the level of electronic anesthesia by gradually raising the amplitude dial until the patient felt a significant sensation. For the patient to acclimatize to the new sensation of electronic anesthesia, this amplitude level was maintained for a initial duration of 20 seconds.
- The amplitude was then increased to next level and the cycle was repeated, until fasciculation or quivering was noted near the pads. Twitching was noted on upper lip and lower eyelid in case of maxillary arch and on lower lip in case of mandibular arch. This was the minimum "therapeutic level of stimulation", at which the procedure could begin.
- If at all pain/discomfort was felt during the procedure, the amplitude was gradually raised to "dail-out discomfort" within the tolerable level of the patient.
- If at any time, the patient felt discomfort while the investigator was increasing the level of TENS, they were instructed to raise their hand and the amplitude was decreased.
- On the completion of the procedure, all controls were returned to zero. The machine was turned off and the contacts were removed.

Pain Assessment :

1) Visual analog scale – VAS : Effectiveness of EDA was evaluated by the patient using a simplified version of visual analog scale[10].Children were asked to indicate how strong their pain was on a horizontal scale from 0 to 10. On which 0 represents "no pain at all" and 10 "the worst pain imaginable", with caricatures of a smiling child at the left end of scale and a tearful child at the opposite end



2) Likert scale : Likert scaling is a unidimensional scaling method, here the parameters which are to be noted are given values form 1-5 by the operator based on the intimate understanding of the subject matter[11]. In this study it was to score the effectiveness of anesthesia produced by EDA for various clinical procedures based on the observation of the facial expression and physical response (bodily movement) and on the verbal complaint made by the patients at the time of the actual procedure [8, 12]. The scores and their definition are given below

Score	1	2	3	4	5
Definition	Most ineffective	Ineffective	Slightly effective	Effective	Very effective

Results :

63 children were treated under EDA, out of which 22 underwent extractions, 19 children required pulp therapy and 22 were restored with stainless steel crowns. Pain was assessed during treatment procedure by Visual analog scale (VAS) and Likert scale. Scores suggested by the children on VAS were categorized into 0-3 indicating no pain to mild pain, 4-7 indicating moderate pain, and 8-10 indicating severe pain. Likert scale was categorized into 1-5 ranging from most ineffective anesthesia to most effective anesthesia obtained.

S. No.	Treatment groups	Visual Analog Scale			Mean ± S.D
		0-3	4-7	8-10	
1.	Extraction (n=22)	10(45.45%)	7(32.8%)	5(22.8%)	4.5 ± 3.2
2.	Pulp therapy (n=19)	6 (31.5%)	6(31.5%)	7(37%)	5.6 ± 3.1
3.	Stainless steel Crown (n=22)	20 (91%)	1(4.5%)	1(4.5%)	1.6 ± 2.0

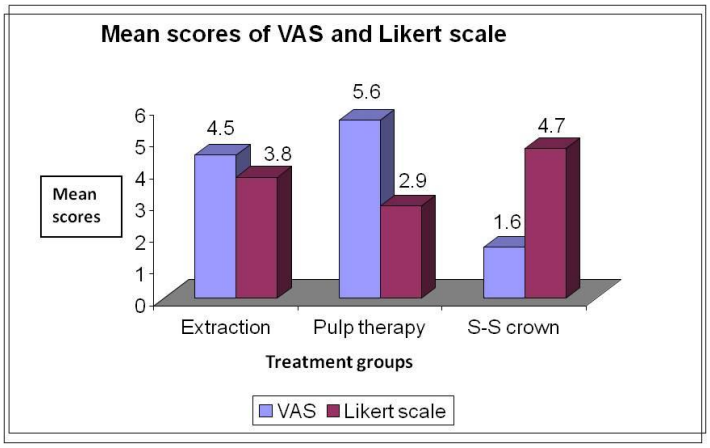
Table 1. Pain perception scores by the patient (VAS) using EDA

S. No.	Treatment groups	Likert Scale					Mean ± S.D.
		1	2	3	4	5	
1.	Extraction (n=22)	2 (9%)	1 (4.5%)	4 (18.2%)	7 (31.9%)	8 (36.4%)	3.8 ± 1.3
2.	Pulp therapy (n=19)	5 (26.3%)	1 (5.3%)	7 (36.8%)	3 (15.8%)	3 (15.8%)	2.9 ± 1.4
3.	Stainless steel Crown (n=22)	0 (0%)	1 (4.5%)	0 (0%)	3 (13.7%)	18 (81.7%)	4.7 ± 0.7

Table 2. Effectiveness of anesthesia by the clinician (Likert scale) using EDA

S.No.	Treatment groups	Spearman's correlation	Significance
1	Extraction	ρ = – 0.76	P < 0.001*
2	Pulptherapy	ρ = – 0.81	P < 0.001*
3	Stainless steel crown	ρ = – 0.66	P < 0.01*

Table 3. Spearman's correlation coefficient between the scores given by the patient and the clinician for EDA (* = Highly significant)



Graph 1: Showing Mean scores of VAS and Likert sale for EDA

Discussion :

Pain control is an important part of pediatric dentistry. The most common form of pain control is local anesthesia obtained by dental injection, which has several disadvantages[1,2,13] viz. patient anxiety, needle phobia, Residual anesthesia, possible systemic toxic reactions from the local anesthetic agent and parasthesia caused by lacerations of regional nerve fibres.

Effective administration of a local anesthetic without the need for injection would be a major advance in dental pain control and would be considered as one of the "holy grails" in dentistry.

Transcutaneous electrical nerve stimulation or electronic dental anesthesia is one such technique which offers the potential of treating many patients with a non-threatening, non-invasive and non-pharmacological analgesic technique.

So this study was conducted to clinically evaluate the efficiencies of EDA in the management of pain during various treatment procedures in children with the sole objective of eliminating needle from pediatric dentistry.

Routine procedures done in pediatric dental clinic which require administration of local anesthesia were selected for the study.

In the first group , 22 children got their teeth extracted. These teeth were either firm, mobile, teeth with intact / resorbed roots or root stumps. Results of this group showed mean score of 4.5 ± 3.2 for VAS and 3.8 ± 1.3 for Likert scale, indicating that majority of the children felt moderate pain / discomfort during extraction and the anesthesia achieved was considered as effective by the clinician. Both the scales showed highly significant coefficient correlation of -0.76 at p<0.001.

It was observed that for extraction of teeth which were firm without any root resorption (3 cases) and also teeth which showed grade I mobility without any root resorption required administration of local anesthesia for completion of the procedure.

But in case of grade I mobile teeth where nearly half of the root was resorbed, extraction could be performed without L. A. though a mild discomfort persisted. Where as in cases of extraction of teeth with grade II mobility and root stumps, patients reported mild or no pain, and for grade III mobile teeth, there was no pain reported. Out of 22 extractions only 2 (9%) required administration of local anesthesia for the completion of the procedure.

In the pulp therapy group 19 children underwent pulpectomy. Results showed mean score of 5.6 ± 3.1 using VAS and 2.9 ± 1.4 using Likert scale. This indicates majority of the patients felt moderate pain/discomfort and anesthesia obtained was considered to be slightly effective. Out of above 19 cases, 5 (26%) required administration of L.A. Both the scales showed highly significant coefficient correlation of -0.81 at p<0.001.

In stainless steel subgroup 22 children had their pulpectomised teeth restored with stainless steel crowns. Results showed mean score of 1.6 ± 2.0 and 4.7 ± 0.7 for VAS and Likert scale respectively. This indicates that children did not experience any pain or discomfort during the treatment and anesthesia obtained was considered most effective.Both the scales showed highly significant coefficient correlation of -0.66 at p<0.001.

But it has been hypothesized that EDA increases the level of patient comfort post operatively.

This seems to be accomplished by 2 mechanisms. First because the flow of blood to the area being treated is increased, the teeth do not have to recover from a loss of blood flow, such as that experienced with injectable local anesthetic. Second, because endogenous opiodids (enkephalins and endorphins) are released and increased feeling of well being may last for hours after the electrodes are removed[14].

The advantages of EDA have been listed by various investigators[15,16,17] that include

- Elimination of pain and fear of dental injection, a non-invasive procedure.
- Elimination of inconvenience of post-operative anesthesia, unaffected speech.
- Elimination of adverse reactions of injectable local anesthetics.
- Elimination of the possibility of infection at the injection site and residual analgesic effect for several hours.

Medical contraindications to EDA include heart disease, cardiac pacemaker or cochlear implant, cerebrovascular disease, seizure disorders, brain tumor or neurologic diseases involving the head and neck and abnormal bruising or bleeding disorders. Use of EDA is also contraindicated in patients undiagnosed dental pain or who have skin lesions or facial abrasions[14].

Although no major adverse effects have been reported, medical contraindications are still to be strictly observed. The only known after effect is the temporary redness of skin over the site of electrode placement due to increased blood circulation to that area. Involuntary twitching of the lip and eyelid muscle is one disadvantageous response to application of electronic anesthesia (EA). Other disadvantages include the sensation of electric pulsations, which may be unpleasant to some patients and inability of EA to achieve profound anesthesia.

During the present study only 2 children (3%) disliked the sensation of electric pulsations. Not even a single case reported post-operative lip biting and skin reactions to the use of the electrodes.

A wild wish would be to work with miniature electrodes, as generally electrodes are cumbersome making treatment procedures more difficult to perform. So a step was taken on this aspect by reducing the electrode size, but still it fell short in fulfilling the above objective.

With the above mentioned suggestions and the encouraging results of the present study along with the background of the previous studies, the stage is set for yet more comprehensive research in fine tuning the delivery systems of EDA. When this goal is achieved by further innovative research, the dream of making needleless dentistry through EDA as a part of routine practice will be fulfilled.

Thus the need of the hour is to use a more comprehensive research by increasing the sample size and limiting the study to the particular treatment procedure. This can be still made precise by using latest technology in modifying the EDA apparatus, for maximizing the efficacy and efficiency of these anesthetic modalities.

Conclusion :

From the results of this study it can be concluded that,

1. Electronic Dental Anesthesia (EDA) can be used for extractions of deciduous teeth with grade II and grade III mobility, root stumps and to some extent extractions of grade I mobile teeth. But EDA cannot be recommended for the extractions of firm teeth.
2. For Pulpectomy, EDA does not achieve profound anesthesia, although procedure could be completed in 74% of the cases using EDA but it failed to achieve complete anesthesia.
3. Anesthesia achieved by EDA was most effective in case of restoration of pulpectomised teeth with Stainless steel crowns, indicating EDA can be used effectively for procedures requiring gingival anesthesia.

Finally, we conclude by saying that, considering acceptable comfort of the child patient and alleviation of pain from and fear of an injection, along with time saved by eliminating the injection and by having a cooperative patient, EDA may be a valuable adjunct to the dentist's armamentarium when used in appropriate manner.

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